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U. S. TECHNOLOGY EXCHANGE WITH THE
SOVIET UNION: A SUMMARY REPORT

Charles Wolf, Jr.

RAND Corporation

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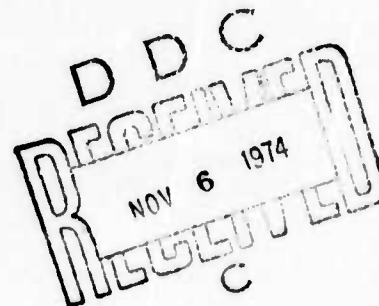
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U. S. Technology Exchange with the Soviet Union: A Summary Report

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A Report prepared for
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A summary of work to date on a Rand project, begun in 1973, which reconsiders U.S. export control policies in the light of recent changes in the international environment, including accords signed in 1972 between the United States and the Soviet Union concerning scientific and technical cooperation. The report discusses the principal study findings on four policy questions: (1) Should existing U.S. policy on the control of high-technology exports to the Soviet Union, China, and other communist countries be made less rigid; if so, how, at what price, and in return for what quid pro quo's? (2) Is there a need for initiating policy actions in order to encourage the import of technology into the United States from the Soviet Union? (3) Can information benefits be realized from the expanding network of East-West trade and technology transactions? (4) How should government policy deal with the pricing of commercially useful technology resulting from government R&D, in international as well as in domestic transactions? The report also deals with links between East-West trade and other foreign policy and national security issues, and points for further study. 48 pp. (see also R-1369-ARPA, R-1406-CIEP/ARPA, R-1414-ARPA, R-1432-ARPA/CIEP.) (MP)

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PREFACE

In May 1972, the United States and the Soviet Union signed an agreement on scientific and technical cooperation which established a joint commission under the co-chairmanship of H. Guyford Stever, Director of the National Science Foundation, and V. A. Kirillin, Chairman of the State Committee for Science and Technology. The commission's purpose was to facilitate technology exchange between the two countries, and to undertake cooperative research and development efforts in several scientific and technical fields, including energy research and development, application of computers to management, and chemical catalysis. Working groups, consisting of experts from the two countries, were formed for the purpose of exchanging scientific and technical information and preparing for the joint R&D efforts envisaged in the May agreement. Other agreements, providing for joint efforts in space, health, and the environment, were concluded at the same time.

While these cooperative arrangements were being made, the United States nevertheless continued to maintain its existing policy of controlling the export of high-technology products and processes to the communist world. Although the number of items subject to control was reduced, controls were maintained in such fields as advanced computers, telecommunications equipment, integrated circuit production equipment, and numerically controlled machine tools. The controls continue to be enforced unilaterally by the United States, and multilaterally in collaboration with its NATO allies (excluding Iceland) and Japan, under a legislative mandate from the Congress begun in 1949 and recently renewed. The original and continuing purpose of the mandate was to deny access by the Soviet Union and other communist countries to advanced technology, which, if readily available to them, might enhance communist military capabilities.

The potential for tension between these two sets of policies--those relating to the continuation of export controls, and those relating to the 1972 accords on scientific and technical cooperation--is evident.

Against this background and in the context of a general expansion of East-West economic relationships, The Rand Corporation began a small

research effort in the spring of 1973 with several aims: (1) to assist the Defense Advanced Research Projects Agency in formulating a research program concerned with implications for the Department of Defense of increased exchange and export of U.S. technology to the USSR, Eastern Europe, and China; (2) to investigate opportunities and methods for enhancing technology flow to the United States from the USSR; (3) to consider whether a suitable price might be placed on exports of U.S. technology, both as an alternative to "go/no-go" export controls to communist countries and as a basis for technology transfers to Western Europe and Japan; and (4) to investigate Soviet interests in and capabilities for using U.S. computer technology and, more generally, aerospace technology.

This work was intended to reconsider U.S. export control policies in the light of recent changes in the international environment, and to consider suitable criteria for formulating Defense Department policy in the interagency machinery that manages these export controls. It was also intended that this research would contribute to a study of U.S. export control policy for advanced computer systems, being undertaken by the Council on International Economic Policy (CIEP).

By the start of 1974, Rand research in this area had resulted in several reports, some under joint sponsorship with the CIEP.¹ Preparation of these reports was accompanied by discussions with members of the ARPA staff, including Mr. Gerald Sullivan and Dr. Verne Fryklund,

¹R-1369-ARPA, *The New Economic Togetherness: American and Soviet Reactions*, N. Leites, The Rand Corporation (forthcoming).

R-1406-CIEP/ARPA, *Estimating the Market for Computers in the Soviet Union and Eastern Europe*, J. P. Stein, The Rand Corporation, May 1974.

R-1414-ARPA, *Technology Exchange--Import Possibilities from the USSR*, J. C. DeHaven, The Rand Corporation, April 1974.

R-1432-ARPA/CIEP, *National Security and Export Controls*, R. E. Klitgaard, The Rand Corporation (forthcoming).

Unpublished working papers on the following subjects have also been completed: The Computer Gap and National Security: Some Implications for Relaxing Export Controls; Technology Export and Public Policy: Some Analytic Issues; The Expected Impact of Computers on Soviet Economic Performance; The Prospects for an "Information Fallout" from the New Technology Transfer Arrangements with the Soviet Union; and A Role for Research Institutes in U.S.-USSR Technology Exchange.

with Dr. Maurice Mountain in the Office of the Assistant Secretary of Defense for International Security Affairs, and with Dr. Gus Weiss in the CIEP. Progress reports were made at an ARPA symposium on technology exchange in September 1973, and briefings on parts of the work were presented to Rand's Board of Trustees and Air Force Advisory Group in November 1973. More extensive presentations were made to an interagency symposium organized by ARPA in February 1974, and to a Defense Science Board Panel on technology assessment in June 1974.

The present report is an overview summary and distillation of the work to date. It is divided into three parts: (1) principal results, (2) links between East-West trade and other foreign policy and national security issues, and (3) issues warranting further study in the broad areas of East-West trade and international technology exchange.

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SUMMARY

The main results of Rand's exploratory work on international technology exchange can be summarized in terms of four policy questions, as follows.

1. Should existing U.S. policy on the *control of high-technology exports* to the Soviet Union, China, and other communist countries be made less rigid; if so, how, at what pace, and in return for what *quid pro quo's*?

The *security* aspects of this question relate to the possible enhancement of Soviet and Chinese military capabilities as a result of relaxing export controls. A preliminary examination of one category of controlled exports, large computer systems, suggests that any such enhancement would probably be modest. It seems unlikely that the advantages of such enhanced military capabilities would be qualitatively different from the advantages that the Soviet Union can already acquire through present uncontrolled exports, as well as through other U.S. policies that facilitate the transfer of technology to the Soviet Union in several high-technology areas. With respect to further relaxation of controls on large computers, the argument depends on an important implicit assumption: namely, that these other, more permissive policies are themselves consonant with U.S. national interests. If this assumption is rejected, then controls should as plausibly be tightened as relaxed.

The *political* gains from relaxation of controls are unclear. There are views on both sides of this question, and little hard evidence exists to confirm or reject either side.

The *economic* gains from relaxing controls, again considered only for the case of large computer systems, can be evaluated quantitatively in terms of possible gains for U.S. exports in Eastern European and Soviet markets, and qualitatively in terms of potential improvements in the performance of the Soviet economy. Both gains appear to be modest.

These preliminary conclusions have several operational implications for current export-control practices. There is a need for additional criteria and new sorts of information in drawing up the list of restricted exports, and in allowing or disallowing exceptions. Instead of asking whether time or resources might be saved by the Soviet military, or its capabilities might be enhanced, analysts should also ask whether the time/resource savings and capability increase would be different from, and militarily more important than, what is already provided to the Soviet Union through other U.S. policies. Further, an explicit effort should be made, in formulating the restricted list or granting exceptions to it, to evaluate specific political and economic gains and losses expected to ensue from the proposed action.

Finally, the United States should probably be more concerned with what it can get in return for relaxing controls than with whether to do so. For example, opportunities for importing technology from the Soviet Union might be improved as one type of recompense.

2. Is there a need for initiating policy actions in order to encourage the *import of technology* into the United States from the Soviet Union?

There may be significant technology in the Soviet Union and Eastern Europe from which the United States might benefit. For example, Soviet inputs into R&D, however measured, have been very large and long sustained. The priorities and content of much of this R&D have differed appreciably from those associated with U.S. technological efforts. Furthermore, various obstacles have interfered with the free flow of information and technology both within the Soviet Union, and from the Soviet Union to the United States. As a result, a stock of opportunities for technology import, from which the United States could benefit, may have accumulated. Some examples of fields in which these opportunities may lie are presented in the text.

To test the hypothesis that these opportunities would be worth pursuing, several suggestions are advanced. One involves the establishment of research institutes and laboratories--along the lines of the Battelle Memorial Institute, the Stanford Research Institute, and Arthur D. Little--to cooperate with or to operate in the Soviet Union, perhaps under some form of joint support from several U.S. firms. Another would focus responsibility within the U.S. government for encouraging the import of technology from the Soviet Union, and for providing an official source of advocacy for a lowering of the existing barriers to such flows.

3. *Can information benefits be realized from the expanding network of East-West trade and technology transactions?*

As a consequence of the near tripling in 1973 of U.S. exports to the Soviet Union and of the doubling of U.S. imports from the Soviet Union, as well as of the emerging activities of the U.S.-USSR Joint Commission on Scientific and Technical Cooperation, several thousand new contacts between U.S. and Soviet citizens have occurred. The question arises whether these new and expanding sources of information could be used to improve our understanding of how the Soviet economy and political system function.

One of the obstacles to realizing such potential benefits lies in the reluctance of many American business and financial people to cooperate in a covert informational venture. This is not to say that there would not be some participants, even so; only that participation--and the resulting information--might be more restricted and less reliable than if the constraint were removed.

For this reason, the experience of the British Board of Trade prior to World War II may be worth careful study. The British Board of Trade chaired an interagency committee of the British government concerned with developing information about German industry and technology out of the numerous contacts between British and German business and financial interests.

A similar function might be usefully performed in the present context, in an open rather than a covert manner, under the aegis of an interagency group headed by the State, Commerce, or Treasury Department, with participation by open intelligence analysts. Such a central group could provide liaison and technical arrangements for Soviet groups visiting this country, as well as for U.S. groups before and after visiting the Soviet Union. One aim of these efforts would be to acquire better information about Soviet organizations and procedures concerned with research and development and new technology, and a clearer picture of how decisions on resource allocation are made in the Soviet economy.

4. How should government policy deal with the *pricing of commercially useful technology resulting from government R&D*, in international as well as in domestic transactions?

This question concerns whether and how commercially useful technology resulting from government-funded R&D, principally that undertaken by the Department of Defense of the National Aeronautics and Space Administration, and the Atomic Energy Commission, should be priced. It includes establishing whether a distinction should be made between foreign and domestic sales of such spin-offs, and between sales to the Soviet Union or other communist countries and sales to Japan or Western European countries.

It seems likely that the *possibility* of applying such a differential pricing policy, quite apart from its *desirability*, depends on certain market conditions in the industries concerned. These conditions include (a) the existence of at least a few U.S. firms that would stand to benefit from the spin-offs from public R&D and that would compete to make technology sales abroad; and (b) U.S. firms as a group selling technology abroad which is special and distinct and not easily displaced by foreign-technology substitutes.

Besides addressing these four policy questions, we have examined several important and surprising ways in which technology exchange and East-West trade are linked with other issues of foreign and national-security policy. These linkages are often obscured by the compartments into which policymaking is divided, where decisions are frequently made. Several such linkages are discussed in relation to the specific case of exports of computer systems to the Soviet Union, Eastern Europe, and Communist China. These linkages include (1) the relation between computer exports and U.S. policies and negotiations in NATO; (2) export policy toward China, and its implications for U.S.-Soviet, U.S.-China, and U.S.-Japan relations; and (3) the connection between technology transfer policies and arms limitations negotiations.

The report concludes with a brief outline of issues that warrant further study. These issues are grouped into three categories: (1) East-West trade and technology exchange with the Soviet Union; (2) U.S.-China technology and trade issues; and (3) general issues of international technology exchange and cooperation.

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In preparing this overview the author has benefited from research done by Rand colleagues Arthur J. Alexander, James C. DeHaven, Joseph Kirschheimer, Robert E. Klitgaard, Nathan Leites, John P. Stein, and Rein Turn, and from comments made on an earlier draft by several of these colleagues and by Abraham Becker, Arnold L. Horelick, A. Ross Johnson, Nancy Nimitz, and Willis H. Ware.

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1. PRINCIPAL RESULTS

Rand's work on international technology exchange has focused on four policy questions:

1. Should existing U.S. policy on the *control of high-technology exports* to the Soviet Union, China, and other communist countries be made less rigid; and if so, how, at what pace, and in return for what *quid pro quo's*?
2. Is there a need for initiating policy action to encourage the *import of technology* into the United States from the Soviet Union?
3. Can *information benefits* be realized from the expanding network of East-West trade and technology transactions?
4. How should government policy deal with the *pricing of commercially useful technology* resulting from government R&D, in international as well as in domestic transactions?

It should be evident that the first and third questions relate principally to transactions between the United States and the Soviet Union as well as other communist countries, while the remaining questions deal with matters that weigh equally on America's international transactions with Western Europe and Japan.

1. EXPORT CONTROLS: ISSUES OF NATIONAL SECURITY, POLITICS, AND ECONOMICS

The issue of export controls involves practices and procedures that have evolved over several decades under the Export Control Act of 1949, the Mutual Defense Assistance Control Act (Battle Act) of 1951, and the Export Administration Act of 1969. Under these controls, the United States and its principal NATO allies (plus Japan) have prohibited the export of military items to communist countries, and have restricted the export of high-technology civilian goods that have military applications, such as advanced computer systems, telecommunications equipment, integrated-circuit production machinery, and numerically controlled machine

tools. These controls have been appreciably relaxed in recent years; the restrictions embodied in the postwar unilateral U.S. Commodity Control List were considerably more stringent than those imposed lately by the multilateral Coordinating Committee (COCOM) list. Nevertheless, several dozen key industrial categories remain under control. In many of these categories, such as those mentioned above, the controlled items represent a substantial proportion (for example, over 50 percent in the case of integrated circuits) of the entire product line.

The question of whether these controls should be further relaxed, and, if so, at what pace and to what degree, involves complex issues of national security, politics, and economics.

National Security. Security aspects concern the enhanced Soviet and Chinese military capabilities that might result from relaxing these controls. To provide a logical case for maintaining controls on high-technology exports, the resulting enhancement of communist military capabilities would have to be substantial.¹ Otherwise, export control policies appear to be fundamentally inconsistent with two other prevailing U.S. policies: those relating to the permission, even the encouragement, of exports of uncontrolled products and processes to the Soviet Union (such as wheat, or production machinery for the large Kama River truck plant, or smaller computers, as well as all computer software), which increased nearly threefold in 1973 to a level of \$1.3 billion; and those relating to the encouragement of technology transfer to the Soviet Union under the May 1972 agreements for scientific and technical cooperation between the United States and the Soviet Union.²

¹For a fuller discussion of these and other points relating to security, see R. E. Klitgaard, *National Security and Export Controls*, R-1432-ARPA/CIEP, The Rand Corporation (forthcoming).

²Under the May 1972 accords, a joint U.S.-Soviet Commission on Scientific and Technical Cooperation was set up with the purposes and structure described in the Preface of this report.

Under Article 4 of these accords, agencies of the Soviet Union are allowed to enter into separate agreements with individual U.S. firms to import technology and management techniques from them. Article 4 provides that "...both Parties will, as appropriate, encourage and facilitate the establishment and development of direct contacts and cooperation between agencies, organizations and firms of both countries and

These uncontrolled exports and technology transfer arrangements save Soviet resources, or contribute to more efficient operation of the Soviet economy. Of course, such resources may be neither easily nor completely transferable to other sectors or uses. Nevertheless, the effect of these benefits is to enable the Soviet Union to realize some enhancement of its military capabilities, if it chooses to use the saved resources for this purpose. Thus, the question arises: how can we continue present U.S. policies on export controls in light of other U.S. policies that facilitate exports of uncontrolled products and technology transfer in other areas? The answer: only if there is something

the conclusion, as appropriate, of implementing agreements for particular activities...."

Further, Article 4 provides that "...agreements between agencies, organizations and enterprises...may cover the subjects of cooperation, organizations engaged in the implementation of projects and programs, the procedures which should be followed, and any other appropriate details."

By early 1974, the Soviet Union had entered into a large number of agreements under Article 4, involving the following companies and areas of cooperation:

<u>Company</u>	<u>Area of Cooperation</u>
Bechtel	Construction methods, planning
Boeing	Civil aviation, air transport technology
Brown and Root	Oil and gas development
Control Data	Computers, peripheral equipment, systems design, computers
Dresser Industries	Oil and gas exploration
General Dynamics	Shipbuilding, aircraft construction, telecommunications, computers
General Electric	Power and electrical engineering, atomic power plants
Hewlett-Packard	Medical electronics, measuring equipment, minicomputers
ITT	Communications technology, electronic components
Joy Manufacturing	Coal mining equipment
Litton Industries	(Not available)
Monsanto	(Not available)
Occidental Petroleum	Oil and gas drilling, refining, agricultural chemicals
Singer	Computers, electronic instruments, textile equipment
Stanford Research Institute	General science and technology
Tenneco	(Not available)

special and different, in quality or quantity, about the potential gain for Soviet military capabilities that would result from relaxation of the export controls, compared with the potential impact of uncontrolled exports and technology transfer agreements under the May 1972 accords. Otherwise the policies on uncontrolled exports and technology transfer can simply nullify the purposes that export controls are intended to accomplish.

Would the capability-enhancing effects of further relaxation of export controls be appreciably different from those already open to the Soviets from the more permissive U.S. policies in these other areas? In an effort to answer this question, we interrogated several experts in the fields of computer technology, military applications, and Soviet studies. The aim was to elicit judgments about the impact on Soviet military capabilities of access to advanced U.S. computers. The exercise focused only on computer technology, particularly potential Soviet military uses of large computer systems in several areas: command and control, logistics, research and development, intelligence, guidance, and anti-ballistic missile systems. The interrogation process was loosely organized, qualitative, and not checked by any other panel of experts or by quantitative calculations. Consequently, the results should be treated with caution and viewed as preliminary, pending further work.¹

Granting these limitations, a summary of the principal results may be of interest. It seems to be the case that, given its military doctrines and procedures, the Soviet Union can usually substitute time, labor, and other military resources to reduce its need for the most advanced large-scale computer systems while producing military capabilities comparable to those of the West's computer-intensive modes of structuring and using forces. Hence, attempted restrictions on Soviet access to large U.S. computer systems will not deny or defer acquisition of many military capabilities that the Soviets have an interest in acquiring. Possible exceptions to this generalization arise in ABM applications, battlefield command and control, avionics, and atmospheric and oceanic modeling. Further work would be required to determine the significance of these exceptions.² Moreover, it

¹See Klitgaard, *op. cit.*

²*Ibid.*

should be emphasized that these points apply only to *large* computer systems, not to microprocessing units and semiconductor memories that can be used for small on-board computer guidance in missile reentry vehicles. These may indeed be of substantial military value to the Soviet Union.

Politics. Political aspects of export controls relate to the political gains that might be realized by relaxing controls, thereby contributing to improvements in the international environment or in the internal political climate within the Soviet Union. Clearly, these aspects pertain to the broad range of East-West economic relationships and the motivations for expanding them, rather than to technology exchange and export controls alone. While it is not implausible to hope for political gains from the expansion of economic relationships, the basis for anticipating such gains is far from clear. Sharply different views are frequently expressed on this issue among segments of the policy community in the United States, on the one hand, and in the Soviet Union, on the other. These divergent views are examined in detail in a separate study by Nathan Leites.²

According to some apparently influential beliefs, more prevalent in the United States than in the Soviet Union, the more extensive the economic relationships between the two countries, the more numerous will be the friendly contacts between American and Soviet citizens, and the lower will be the Politburo's fear of and hostility toward the United States, and its motivation and capacity--with regard to its own society--to act against the United States. All of this assumes a high level of ability, on the U.S. side, to influence separate elements of Soviet society, as well as a strong influence on the Politburo by elements of Soviet society which might thereby become more friendly to us. Each of these assumptions, while not disprovable, is not proven but merely asserted--and each seems dubious.

¹Nathan Leites, *The New Economic Togetherness: American and Soviet Reactions*, R-1369-ARPA, The Rand Corporation (forthcoming).

Another view characteristic of the optimism of various segments of the U.S. policy community is that the more extensive the Soviet-American technological and economic exchanges, the less the Politburo will be inclined to put the U.S. contribution to its economy at risk by a bold, expansionist policy abroad. In opposition to this view, it can be argued that major expansionist efforts are likely to be undertaken by Moscow only to avoid losses or to secure gains of a size that would in any event dwarf the economic benefits thereby imperiled. Furthermore, Washington may itself be more susceptible than Moscow to pressure from those in the United States whose particular interests stand to gain from maintenance of the economic status quo.

Soviet viewpoints stand in contrast to these optimistic American views concerning the effects of expanded economic relations on Soviet behavior. The Soviet Union, while welcoming such relationships as contributing to mutual economic advantage and a reciprocal easing of political tensions, explicitly denies that political gains hoped for by the West will ensue. According to Soviet views, expanded East-West trade is a sign of Soviet "dynamism" and of the growing strength of the socialist system. However, such views are often accompanied by misgivings, and even guarded shame, that the new trade seems to follow a "colonial" pattern, with raw materials exported by the Soviets in return for high-technology products from the West.

As Leites also points out, the Soviet Union's adoption of a more moderate international stance, and its sharp reduction in ideologically loaded rhetoric, may result not so much from a desire to obtain economic benefit as from the Soviet rulers' gradual progress to the insight that rudeness and offensiveness in international affairs are as likely to be punished as rewarded. The Soviet rulers seem to have recognized that there are any number of situations where one most fully exploits another's weakness, not by pressing against him, but by appearing to support him.¹

In any event, there seems to be little hard evidence to confirm or reject the various opposing views about the general political consequences of expanding East-West economic relationships and relaxing export

¹ *Ibid.*

controls. Each of us remains his own expert on the matter of political gains. In particular diplomatic and negotiating contexts, however, the case for expecting such gains may be stronger than it is as a general proposition.

Economics. One economic aspect of export controls on high technology products and processes relates to the potential gains for U.S. exports if Eastern European and Soviet markets were opened up to these now-controlled exports. In the Rand work on international technology exchange, a method developed for estimating the size of potential markets has been applied to one category still subject to control, namely, computers.¹ The potential market for computer exports to Eastern Europe and the Soviet Union is estimated as the difference between (a) that area's desired demand for computers of Western quality and cost, and (b) the number of computers obtainable from the growth of internal production without additional imports from the West.² By this method, it is estimated that the complete relaxation of export controls on advanced computers would open up a market for U.S. exports to Eastern Europe and the Soviet Union which could, under favorable assumptions, reach \$300 million annually by 1985.

This estimate should be regarded as an upper bound in view of the optimistic, and probably unrealistic, assumptions that underlie it.³

¹ John Stein, *Estimating the Market for Computers in the Soviet Union and Eastern Europe*, R-1406-CIEP/ARPA, The Rand Corporation, May 1974.

² The desired demand in Eastern Europe and the Soviet Union is derived from a regression model that explains computer demand per capita as a function of per capita GNP and a time-variable. Using Western European data, the coefficients of both independent variables are highly significant and the explanation of intercountry variance in computer demand is extremely high. See Stein, *op. cit.*, pp. 11-21.

³ They include the following: Soviet and Eastern European capacity to pay for such imports would not be constrained; Soviet computer production would be limited to a fraction of its currently planned growth (which is perhaps not too unlikely); the average dollar value of exported Western computers would remain constant at the average value of computer systems currently installed in the West, notwithstanding the decrease in computer prices and an increasing share of the relatively inexpensive minicomputers in export markets; and the U.S. share of computer exports to Eastern Europe and the Soviet Union would rise from its currently small proportion to over half of the total.

Because of these assumptions, relaxation of export controls on computers would probably result in a smaller increase in U.S. exports than \$300 million. With total exports of computer systems by U.S.-based firms of about \$4 billion in 1971, it would be surprising if additional exports to Eastern Europe and the Soviet Union were to reach a rate of 5 to 10 percent of the annual total during the next decade. Such an increase would represent a non-negligible, yet hardly substantial, gain from a national viewpoint, though it could be of great consequence for individual firms.

The method that has been developed for estimating the market for computers could, of course, be used to estimate the potential market for other high-technology product lines as well.

Another economic aspect of export controls concerns the possible improvement in the performance of the Soviet economy resulting from increased imports of now-controlled high-technology products and processes. This aspect has also been investigated as part of Rand's work, again using computers as a case in point.¹ Computers would seem to be a good example of the burgeoning Soviet interest in acquiring U.S. technology. The strong Soviet motivations that lead to this particular demand relate to the hope that advanced computer technology can help offset the increasing inefficiency of the statewide planning system, the falling growth rate of the economy, and the near collapse of growth in total factor productivity in the Soviet Union.²

Based on a brief qualitative review of the problems encountered in the Soviet statewide planning system and in the operation and management of the economy, it seems unlikely that computer technology will bring major, or perhaps even discernible, improvements in Soviet growth and productivity. Strong structural forces would tend to limit Soviet economic gains--the same forces that pervade the Soviet system, shaping its goals and incentives.

What answer, then, can be offered to the original question: Should present policies on export controls be further relaxed? The answer takes

¹ An unpublished working paper by Arthur J. Alexander examines this issue.

² *Ibid.*

the form of several preliminary conclusions, which are briefly summarized below. As noted earlier, the conclusions are based principally on work with computers, and should not be extended to other categories of advanced technology without further analysis. Moreover, some of the conclusions pertaining to computers also warrant further study.¹

1. The *security* costs and risks from relaxing export controls on large computers are probably not so great as they were thought to be when the current control thresholds were originally established. It seems unlikely that the military advantages that would be opened to the Soviet Union from such relaxation would be qualitatively different from the advantages that they already receive through uncontrolled exports and through other U.S. policies that facilitate the transfer of U.S. high technology to the Soviet Union. While this line of reasoning leads to relaxing controls on certain *large* computer systems,² an important and certainly arguable assumption underlies this conclusion: namely, that these other, more permissive policies are consonant with U.S. national interests. Were the assumption to be rejected, such policies should be tightened without further relaxation of export controls on computers.
2. The generalized *political* gains from such relaxation are at best unclear. There are views on both sides of the question, but little hard evidence by which to confirm or reject either side. Whether diplomatic gains can be realized from politically advantageous bargains is not subject to convincing demonstration as a general proposition, although it may be persuasively argued in particular cases.
3. The *economic* gains from relaxing controls can be evaluated quantitatively in terms of possible gains for U.S. exports in

¹For example, see the discussion in Sec. III, below, of the effects on Soviet military capabilities of acquiring Western technology.

²Particularly those that do *not* involve the most advanced integrated circuitry, which would be useful for developing *microprocessing* units.

Eastern European and Soviet markets, and qualitatively in relation to potential improvements in the performance of the Soviet economy. Both types of gains appear to be modest.

4. Certain operational implications for current export control practices follow from the previous discussion. In formulating the list of restricted exports, and in allowing or disallowing exceptions, there is a need for additional criteria and additional information. At present, the process concentrates on whether resources or time could be saved by the Soviet military, or whether Soviet capabilities could be enhanced, by the removal of an item from the control list. If the decision is affirmative, the item remains on the list. The previous discussion suggests that several changes in this process would be desirable: (a) The information sought should not focus solely on whether *any* savings or capability increases would be afforded the Soviet military, but on whether these savings and increases would be greater and militarily more important than those already provided to the Soviet Union through other U.S. policies on trade and technology export, previously discussed. (b) An effort should be made in the list review process to evaluate the specific political and economic gains and losses expected to ensue from the particular action.
5. Finally, the United States should probably be more concerned with what it can get in return for relaxing controls, than with *whether* to do so. Such returns can be cast in terms of maximizing the price derived for exports of high-technology products and processes. In this context, the appropriate components of price may include other aspects of East-West relationships than simply payments in dollars, although realizing these other components may be more difficult and less reliable. One of them relates to opportunities for, and barriers to, the import of technology from the Soviet Union.

2. THE IMPORT OF TECHNOLOGY

The second policy question with which Rand's work has been concerned relates to technology import: whether a policy should be initiated

(where one does not now exist) to stimulate the flow of technology from the Soviet Union to the United States? In contrast to the case of export controls, there is no explicit legislative or administrative responsibility within the U.S. government for the import of technology from the Soviet Union, or indeed from any other areas. Should there be such a responsibility? Is the amount of technology in the Soviet Union and Eastern Europe which the United States can use a significant one? And in what areas of technology are the Soviets most likely to have information from which we can benefit, thereby saving R&D and other resources?¹

The basic reasons for believing that there may be significant technology in the Soviet Union and Eastern Europe from which the United States can benefit are as follows, although they are far from conclusive: (1) Soviet inputs into R&D--whether measured in rubles, scientists, engineers, laboratories, or other resources--have been very large and sustained over a long period.² (2) Many of the priorities and much of the content of Soviet R&D have differed from those associated with U.S. technological efforts, because of differences in physical geography, climate, demography, national purpose, and doctrine. (3) Much of the product of this R&D has remained unused, owing to insufficient incentives for application by Soviet industry. (4) Various obstacles have interfered with the free flow of information and technology from the Soviet Union to the United States in past years, obstacles that include differences in industrial standards, restrictions on the movement of people and information, language difficulties, and perhaps the lack of sufficient U.S. industrial representation and participation in the newly organized U.S.-USSR Joint Commission on Scientific and Technical Cooperation.

If one draws a distinction between the "technology of the laboratory" and the "technology of the factory," or if one arrays "basic" research at one end and "applied" research and production technology at

¹These and related issues are examined by James C. DeHaven in *Technology Exchange--Import Possibilities from the USSR*, R-1414-ARPA, The Rand Corporation, April 1974.

²*Ibid.*, pp. 8-11.

the other end of the R&D spectrum, the comparative advantages of the Soviet Union probably lie with the technology of the laboratory and the more basic types of research. Consequently, these seem to be the most fruitful areas in which to facilitate wider access by U.S. firms, as well as government representatives, with a view to technology import from the Soviet Union.

To facilitate such import, research institutes could be established to search out useful technological ideas in the Soviet Union, to develop the inventions where necessary, and to arrange for their exploitation by U.S. firms. Organizations that are proficient in just these tasks include the Battelle Memorial Institute, the Stanford Research Institute, and Arthur D. Little. Such firms might be encouraged to cooperate with, and to operate in, the Soviet Union, perhaps under some form of joint support.

Promising areas for technology import include construction materials, metals, plastics, mastics, lubricants, coolants, and hydraulic fluids designed for use under extreme temperature conditions; processes for producing and fabricating heavy castings, forgings, plates, and weldments; operations and construction in permafrost and tundra regions, such as those that the United States will be faced with in construction of the Trans-Alaska Pipeline; and technology for protecting high-voltage lines and switching stations against lightning damage and other severe climatic conditions.¹

Finally, it would seem desirable to pinpoint responsibility within the U.S. government for encouraging the import of technology from the Soviet Union and lowering the barriers to such flows. This action would permit a fair test of the hypothesis that there are, indeed, promising opportunities for the U.S. from technology import.

3. INFORMATION IMPLICATIONS

The third policy question relates to the implications of technology exchange, and of the generally expanding network of East-West trade, for improving our understanding of technology and decisionmaking in the Soviet Union.

¹*Ibid.*, pp. 31-36.

In 1973, U.S. exports to the Soviet Union rose almost threefold to an annual rate of over \$1.3 billion, while exports from the Soviet Union to the U.S. doubled, reaching a level of about \$180 million. If most-favored-nation treatment is provided for Soviet exports to the United States, further increases might occur. And if the serious limitations on present Soviet capacity to pay are loosened, prospects would brighten for further increases in U.S. exports to the Soviet Union.¹

In connection with this actual and potential trade expansion, numerous Soviet trade delegations have been visiting plants and ports throughout the United States, and large numbers of American business and financial people have visited the Soviet Union, although restrictions are placed on their movements outside Moscow. Furthermore, under the U.S.-USSR Joint Commission on Scientific and Technical Cooperation and its working groups,² several dozen Soviet and U.S. technical experts will be in more or less regular contact in the areas covered by these and other arrangements. All together, several thousand additional individual contacts between Americans and Russians now exist on business and technological matters.

As a consequence of these developments, new and expanding sources of information may be available about the economy, the technology, and the organizational behavior of the Soviet Union. The question arises whether these new sources can be effectively used to improve our understanding of how the Soviet system functions in economic and technical areas.³

Several obstacles stand in the way of realizing informational benefits from expanding East-West trade. A minor obstacle lies in doubt about the ability of the technical people involved in these activities to furnish information that goes beyond the useful but narrow details

¹See the discussion of capacity to pay, below.

²See above, Sec. I.

³The question is briefly discussed in an unpublished working paper by Joseph M. Kirchheimer, dealing with "Prospects for an 'Information Fallout' from the New Technology Transfer Arrangements with the Soviet Union."

of their own direct concerns to reach broader issues of resource allocation and decisionmaking. A more serious obstacle probably lies in the reluctance of U.S. business and financial people to cooperate in such a venture if handled in a covert manner. This is not to say that there would not be *some* participants, only that the participation and the resulting information might be more restricted and less reliable than if the constraints were removed.

With these informational aims and constraints in mind, it seems desirable to examine the analogous experience of the British Board of Trade prior to World War II in developing and analyzing information concerning German industry and technology resulting from the numerous contacts between British and German business and financial interests. A preliminary review of this prior experience, keeping in mind the desirability of conducting this activity in an open rather than a covert manner, leads to several conclusions:

- a. Consideration should be given to having this function performed outside the intelligence community, under the aegis of an interagency group that might be headed by the Department of State, the Department of Commerce, or the Department of the Treasury, with participation by open intelligence analysts but under the guidance of the National Security Council.¹
- b. Such a centralized group could be responsible for providing liaison and technical arrangements for Soviet groups visiting this country, as well as for U.S. groups before and after visiting the Soviet Union.
- c. A major aim of the entire effort would be to provide the U.S. policy community with a better understanding of the organizations and procedures concerned with research and development and new technology in the Soviet Union, and a clearer picture of how decisions are made and resources allocated in the Soviet economy.

¹ Further details are described in Kirchheimer's paper.

4. PRICING COMMERCIALY USEFUL SPIN-OFFS FROM GOVERNMENT-FUNDED R&D

If U.S.-based firms sell their technology abroad too cheaply, international technology transfer may involve national economic losses. This outcome may be the more likely in cases where the R&D costs of this technology have been incurred by the government.

As noted earlier, this issue bears more heavily on U.S. technology transactions with Western Europe and Japan, than on those with the Soviet Union and Eastern Europe. The general question is whether and how commercially useful technology resulting from government-funded R&D, principally that undertaken by the Defense Department, the National Aeronautics and Space Administration, and the Atomic Energy Commission, should be "priced." The term "price" is used in its most general sense to include taxes, or fees on sales, sales of patent rights, royalties from licensing agreements, and other arrangements that have in common the feature of attaching a cost to the user and providing a return to the government. The question is thus closely linked to the issue of so-called R&D recoupment policy--that is, whether and how the government should undertake to recover part of its R&D costs, or to defray part of its subsequent R&D costs by extracting a fee from users.

Several component questions arise in this connection: (a) Should *any* price or fee for such commercially useful by-products be charged by the government? (b) If so, which policy instruments should be used (e.g., taxes, fees on sales, etc.), and under what circumstances? (c) Should a different policy be applied if the user or buyer of such technology is a foreign (rather than a domestic) corporation or agency? (d) Should a further distinction be made if the user or buyer is the Soviet Union or some other communist country, rather than a U.S. ally such as Japan or a Western European country?

Only two of these component questions--(a) and (c)--have been addressed by the Rand work so far, and these only in a preliminary manner.¹ We hope to do further work on this set of questions in the near future.

¹A preliminary discussion of the subject is contained in an unpublished working paper by Charles Wolf, Jr., on "Technology Export and Public Policy: Some Analytic Issues." See also Klitgaard's discussion of optimum tariff theory in relation to export controls, *op. cit.*

The preliminary conclusions from the work done so far are as follows:

1. Whether a "price" should be charged for commercially useful spin-offs probably depends on whether the quantity and composition of *subsequent* R&D would be affected by the revenues thus recovered. If subsequent R&D would be altered (e.g., as a result of altered decisionmaking by the agencies concerned, or by the Congress), there may be good reasons for extracting such revenues. These reasons, having to do with the incentives for technological advances, are analogous to the efficiency reasons for patents and licensing fees in the private sector.
2. Furthermore, there may be distributional reasons for capturing revenues, since the spin-offs would otherwise result in concentrated benefits for a few firms in non-competitive industries. Charging a price for the spin-offs can, in such cases, reduce the "economic rents" or monopoly profits of these firms, as well as the burden imposed on taxpayers to support government R&D.
3. Whether a *differential* price should be charged to foreign and domestic buyers of technology is likely to depend on the desirability of trying to get foreigners to bear some of the long-run R&D costs otherwise borne by taxpayers in the United States, and on whether the prospects for retaliation by foreign countries might make this outcome undesirable from the standpoint of U.S. consumers.
4. Whether a differential pricing policy *can* be charged, quite apart from its desirability, probably depends on whether certain market conditions prevail in the industries concerned. These conditions include (a) the existence of at least a few U.S. firms that would stand to benefit from the spin-offs from public R&D and that would compete to make technology sales abroad, thereby tending to drive the price of technology down, and (b) U.S. firms as a group selling technology abroad which

is special and distinct and not easily displaced by foreign-technology substitutes (i.e., whose price elasticity of foreign demand is very low).

II. LINKS BETWEEN EAST-WEST TRADE AND OTHER FOREIGN POLICY AND NATIONAL SECURITY ISSUES

Technology exchange and East-West trade impinge on other issues of foreign and national security policy in several important and surprising ways. The following discussion will be principally concerned with the example of computers and with how export controls on advanced computer systems bear on other foreign policy issues. In this case, as in others, it is important to identify the linkages, because they are often obscured by the compartments into which policymaking is frequently divided. The parts of the policy community concerned with technology exchange and East-West trade are not the parts concerned, say, with NATO, with U.S.-Japan relations, with U.S.-China relationships, with the Strategic Arms Limitations Talks (SALT), or with foreign aid to less-developed countries. Yet these other domains may be seriously affected by actions (or inaction) in the area of East-West trade and technology exchange. For example, it is plausible that discussions with the Japanese concerning base rights and possible cost-sharing arrangements for U.S. bases in Japan may be connected with decisions that the United States makes on export controls applicable to computer sales to mainland China through the COCOM procedures in which Japan participates.¹

A clearer perception of these linkages within the policy community should contribute to a more complete and reliable evaluation of alternative policies, and hence to improved decisions.

1. THE LINK BETWEEN COMPUTER EXPORTS AND NATO

It seems generally to be the case that the NATO allies of the United States balk at the maintenance of export controls, and that the

¹This example recalls an earlier instance where the unfortunate consequences of compartmentalization in policymaking were manifest. In the late 1960s the United States was negotiating for base rights with Thailand, while flooding some of Thailand's Southeast Asian markets with competing supplies of rice under the U.S. foreign aid program. Neither those concerned with base-rights negotiations nor those concerned with the U.S. rice shipments were aware of the important links between the two from the standpoint of Thailand.

United States incurs political costs by maintaining these restrictions. In the case of computers, however, there is an interesting departure from this pattern. Some of the NATO allies are concerned lest the relaxation of controls proceed too rapidly, because Western Europe's exports of computers currently amount to over two-thirds of Soviet imports. Soviet imports of computers consist mainly of smaller systems having capabilities below the performance thresholds for capacity, speed, input-output, and peripheral equipment specified in the prevailing COCOM controls. The Western European countries are therefore concerned lest a relaxation of these controls, by releasing the upper end of the technology spectrum where U.S. exports have a competitive advantage, would cause Western European exports to be replaced by those from the United States.

In some cases, opposition by some COCOM members to present controls may be combined with concern that relaxation might proceed too rapidly. For example, the Europeans may not want the present limitations on exports of computers--at a processing data rate greater than 8 million bits per second--raised above 32 mbs, a level at which the competitive position of U.S. firms would be dominant.

Existence of this linkage does not imply that present export controls should be either maintained or relaxed, but it does suggest that the question of relaxation might appropriately be considered as a part of U.S. bargaining and negotiating with other NATO countries, matters with which export controls are usually unconnected.

2. TECHNOLOGY TRANSFER AND ARMS LIMITATIONS

A second linkage concerns whether potential military benefits to the Soviet Union or China from technology transfer should be related to arms limitations discussions; for example, to the SALT talks or to discussions of Mutual Balanced Force Reductions (MBFR).

We have discussed, above, whether the Soviet Union might realize significant military gains from the relaxation of export controls on large computer systems. Such gains might accrue (a) in the strategic context, through the improved targeting of anti-ballistic missile systems, and (b) in the context of theater war, through improvements in

battlefield command and control, and through the increased flexibility and accuracy of precision-guided munitions.

In such cases--and they may be relatively few--where military gains (substantial cost-saving or capability-enhancing) might be extracted from further technology transfer, the proper inference may *not* be to seek to prevent those possibilities from becoming available to the Soviet Union. Instead, such potential military gains might be considered in exchange for Soviet *military concessions*, as with respect to the numbers of launchers in allowable strategic forces, or to the size and composition of Warsaw Pact general purpose forces.

In other words, the transfer of "civilian" technology with a potential impact on Soviet military capabilities should also be evaluated in relation to the capabilities whose limitation we are trying to negotiate through SALT and MBFR. The two sets of policy issues should be linked, not separated.

3. EXPORT CONTROLS AND OTHER ASPECTS OF INTERNATIONAL TRADE AND FINANCE

One aspect of this type of linkage is referred to above, in discussing the apparent conflicts between several different U.S. policies: those relating to export controls on high-technology products and processes, and those relating to the permission and promotion (through concessional credit financing) of other exports, including wheat and truck production machinery, and to the transfer of advanced technology in certain fields through the U.S.-USSR Joint Commission on Scientific and Technical Cooperation. These differing policies appear to conflict with one another in fundamental ways. On the one hand, export controls are meant to deny to the Soviet Union access to key resources such as advanced computers, which it is believed would permit them to enhance their military capabilities significantly. On the other hand, access to uncontrolled exports, as well as to technological information through the procedures set up by the U.S.-USSR Joint Commission, would again permit the Soviet Union--because of the additional resources that become available for such purposes, or because of improvements in the efficiency with which constant resources devoted to military purposes can be used--to enhance its military capabilities. Unless the military gains *denied* to the Soviets are "qualitatively" (which is to say,

substantially, or appreciably) different from the gains *provided* to them, the two sets of prevailing policies are inconsistent. Consistency might be established either by further relaxing controls, or by further restricting the currently allowed trade and confining the areas of scientific and technical cooperation.

However, a fair evaluation of these sharp alternatives, as well as of various intermediate ones, is inhibited by compartmentalization within the responsible policy community. For example, export promotion and credit extension lie in the purview of the Department of Commerce, the Export-Import Bank, and the Department of the Treasury; the transfer of advanced technology under the May 1972 accords lies in the purview of the National Science Foundation; and export controls operate under the aegis of interagency committees including representation from the Commerce, State, and Defense departments. Although membership in these several communities is overlapping, the fact of separate organizations and operations does not facilitate a direct confrontation of the issue.

A related issue is whether, if export controls were relaxed, there would be increased pressure on the U.S. government from the business and financial community for concessional credits to finance expanded exports to the Soviet Union. As long as export controls have been in effect, the onus of limited trade has tended to fall on these sectors. If the controls were removed or relaxed, the limited capacity of the Soviet Union to finance such imports by expanding its own exports or by selling gold stocks¹ would become more noticeable. Hence, pressure to augment that capacity by concessional credits from the Export-Import Bank, or by other governmental means, may grow.

The results could well be adverse to the United States. The doubts of U.S. allies would be renewed as to whether the advantages of being inside the alliance match those of being outside, and the less-developed countries' views about the parsimoniousness of U.S. foreign aid would be reenforced. This, of course, does not imply that export controls should be retained. It only suggests another linkage between controls and other aspects of U.S. foreign policy.

¹See the discussion of capacity to pay, below.

III. ISSUES FOR FURTHER STUDY

A number of issues bearing on the preceding discussion warrant further study. Some of them relate to international trade with the Soviet Union and China, and to technology exchange; others to trade and technology transactions with American allies in Western Europe and Japan. At a time when economic cooperation with "adversaries" is becoming an increasingly prominent feature of American policy, it is perhaps especially important to promote opportunities for closer cooperation with our allies. Otherwise, we may confront the irony of a policy orientation that seems to these allies to favor adversaries, while we bargain hard on trade, technology, and monetary arrangements with our friends--with further disruptive effects on the strained structure of our alliances.

The selection of issues for further study is loosely based on several criteria: a connection with the discussion in Sec. II, especially as relating to export controls and opportunities for technology import from the Soviet Union; a connection with other major national security and foreign policy problems discussed in Sec. II; and a potential contribution to improvements in technology exchange and economic cooperation with our allies, as well as with the Soviet Union. The issues fall into three categories: (1) East-West trade and technology exchange with the Soviet Union; (2) U.S.-China technology and trade issues; and (3) general issues of international technology exchange and cooperation.

1. EAST-WEST TRADE AND TECHNOLOGY EXCHANGE WITH THE SOVIET UNION

A. Effects of the Acquisition of Western Technology on Soviet Military Capabilities

Instead of approaching national security aspects of export controls from the direction of whether relaxation of controls (e.g., on computers) would affect Soviet military capabilities, the problem might be turned around. We might consider which aspects of Soviet military capability would be of *greatest* concern to us were they to be enhanced--e.g., MIRVing of the missile force, satellite reconnaissance,

precision guidance for air defense or for air-delivered attack ordnance.¹ Next, we would consider what specific component technology, or system technology, these enhanced capabilities depend on--e.g., laser optics, electronic optics, on-board computers. The aim would be a clear indication of the functional relationships involved: the costs to the Soviet Union of achieving equivalent military enhancement with and without access to the component technology. The investigation should also address the question of how, if controls were relaxed, exports of component technology would contribute to Soviet acquisition of the technology in question, whether in terms of increased speed or of reduced acquisition costs. The study should consider how these gains compare with those open to the Soviet Union through now uncontrolled exports, and through technology accessible to the Soviet Union by other means, such as by the agreements with the private firms under Article 4.² Finally, the study should also consider how such a process of investigation can be grafted onto present export controls, through changes in the questions asked, the information sought, and the criteria applied.

A useful case study might, for example, be made of precision-guided munitions (PGMs), an area where the United States is believed to have a significant technological lead over the Soviet Union. In this case, the first question to be addressed is whether Soviet acquisition of PGMs (beyond the wire-guided antitank weapons they already possess) would lead to an enhancement of capability of substantial concern to the United States. If it would, we would try to identify the component technology that such a potential capability enhancement would depend on, and the ways in which present export controls may impede access to this technology. Finally, the study would investigate whether alternative access to the requisite technology is perhaps provided by other products and processes that are *not* subject to control at all.

Such a study would benefit both from calculations of the quantitative relationships described and from a systematic Delphi treatment.

¹"Greatest" because those Soviet capabilities that are of *lesser* concern could probably be enhanced anyhow by the resource-saving advantages realized from other imports *not* subject to controls.

²See above, Sec. I.

The latter would attempt to structure the judgments of a suitably selected group of experts in a more formal and precise way than was done in the illustrative exercise described earlier.¹

B. Technological Cooperation and Export Controls

It would seem timely to evaluate the relationship between U.S. and COCOM export control policies, on the one hand, and the policies of technological cooperation with the Soviet Union under the U.S.-USSR Joint Commission on Scientific and Technical Cooperation, its subsidiary working groups, and the separate Soviet arrangements with private U.S. firms, on the other. Besides addressing the central question of the consistency between these two sets of policies, this evaluation should be concerned with the relative effects of each in reducing the putative "gap" in Soviet technology in particular fields. The study should address the costs and the gains for both sides from these two sets of policies, the relationship of each to furthering or inhibiting an international environment of détente, and the reaction of third countries (especially NATO allies and Japan) to each, considered separately as well as together. Clearly, for some (but not all) parts of this evaluation, qualitative rather than quantitative estimates will be necessary.

C. The Impact of Technology Imports on the Soviet "Absorption" Problem

The Soviet decision to push for rapid trade expansion, particularly imports of advanced technology, is related to domestic economic difficulties of the past decade. The Soviet economy has fallen off its high growth path of the 1950s, owing to increasing tightness of the labor supply and faltering productivity. The latter reflects deep-rooted systematic deficiencies leading to enterprise incentives that are insufficient to promote a rapid rate of technological innovation.

To a considerable extent, Soviet leaders acknowledge this diagnosis; since 1965 they have attempted in a number of ways to reform Soviet economic organization. But these efforts have not succeeded

¹See above, pp. 4-5, and Klitgaard, *op. cit.*

in restoring Soviet growth, and the government does not seem prepared to institute the more thoroughgoing reform that alone might be capable of doing the job. Thus, in seeking to expand imports of advanced technology--whether in the form of machinery, or of know-how (licenses, patents)--the government is hoping to find an alternative means of raising productivity at home.

In the light of what we observe in the Soviet economy, particularly the inability of central planners to induce managers to innovate and introduce new technology (the so-called "technology absorption" problem), we would predict that the impact of Western technology will not be drastic. The enterprise that is reequipped with the latest Western machinery will probably operate more productively after the change than it did before, but there is nothing to indicate that the physical change alone will transform incentives and therefore behavior. The mere importation of advanced technology should provide a series of one-shot effects without necessarily leading to a chain-reaction. Since the early 1960s, a number of such one-shot palliatives (e.g., the various administrative-planning reforms) have enabled Soviet leaders to "muddle through," avoiding both economic stagnation and the need for more radical reform.

This prediction can be fully tested only as the Soviet technology import program proceeds. However, a partial view and tentative conclusions can be drawn by examining the way in which Soviet efforts to introduce selected Western technology through machinery imports in the past, especially in the 1920s and early 1930s and again in the 1950s, have been absorbed in various branches of industry. This examination should also provide a base for forecasting changes in Soviet trade policy--e.g., with regard to favored instruments of trade and types of exchange relationships with Western firms--and for improving our assessment of the opportunities for and constraints on Soviet policy in third areas--e.g., in the Middle East.

D. Capacity to Pay

The question of the Soviet Union's capacity to pay for imports in high-technology fields is of pervasive importance, whether the issue

concerns product imports, or joint investment ventures, or licensing as possible channels for technology transfer.¹ To expand its limited capacity, the Soviet Union has three options: increasing exports, selling gold from inventory or current production, and obtaining outside credits.

Increased exports depend, in part, on most-favored-nation (MFN) treatment for Soviet and Eastern European products in U.S. markets. Most Soviet exports to the United States are not seriously impeded by the absence of MFN treatment. Indeed, the Soviets already enjoy sellers' markets in the United States with respect to platinum and chromium ore. In these cases, the limitation on Soviet capability to export is Soviet capacity to produce, rather than MFN. Exports of Soviet manufactured products tend to be limited by factors of quality, maintainability, and price. In any event, it should be possible to estimate the prospects for an expansion of Soviet exports in various product lines, and how these prospects would be affected by MFN treatment.

Another means of expanding capacity to pay is through sales of gold from stocks or new production. Data on Soviet gold holdings and production potential are of questionable reliability. Soviet gold stocks in 1972 were reported as nearly 2,000 metric tons, or over \$9 billion at prevailing market prices. Soviet gold sales in 1972 were about 150 tons. In other recent years, sales have ranged as high as 500 tons (1965), the proceeds serving to meet the Soviet Union's needs for international liquidity. As the world's second largest producer (after South Africa), the Soviet Union is currently estimated to produce around 200 tons of gold annually, worth about \$700-800 million; but there is little information on the expandability and real costs of Soviet production.²

¹For a brief discussion of certain aspects of the Soviet Union's capacity to pay for imports, see the author's testimony before the Subcommittee on International Cooperation in Science and Space of the House Committee on Science and Astronautics, December 6, 1973. Charles Wolf, Jr., *Technology Exchange Between the United States and the Soviet Union*, P-5138, The Rand Corporation, December 1973.

²*Ibid.*, pp. 4-5. See also *Soviet Economic Prospects for the Seventies*, a compendium of papers submitted to the Joint Economic Committee, Congress of the United States, June 27, 1973, Washington, D.C.

Finally, the Soviet Union might obtain outside credits, either from the U.S. governmental sources (the Export-Import Bank) at concessional terms, or from the private banking and financial community. There are strong reasons why the second of these sources should be preferred from the U.S. point of view, and the first from the Soviet point of view. Soviet access to credit from private financial sources is itself likely to depend on the two preceding types of liquidity growth--increased exports and gold sales.

Choice of means of paying for Western imports can affect the effort to increase productivity through trade. Dipping into gold stocks or obtaining long-term concessional credits would be the simplest arrangement from the Kremlin's viewpoint, because it obviates the need for developing special export lines to finance required imports. And Soviet leaders still tend to emphasize imports in thinking about trade. Furthermore, the Soviet Union remains a centrally planned economy in which foreign trade is unlikely in the foreseeable future to loom large in total output. In any case, the options of credits and gold sales seem least likely to make waves on the Soviet scene and may be preferred for that reason.

On the other hand, perhaps the most lasting benefits from the Soviet standpoint might be obtained by developing lines of manufactured goods, especially machinery and equipment, for export (perhaps on a buy-back basis). The necessity to meet foreign competition might force planners to seek new approaches in economic organization for the export industries. From there, the effects might spill over to branches not specifically producing for export.

In sum, it would be desirable to explore each of these components of the Soviet capacity to pay, because of their pervasive influence on financing the entire range of East-West trade and technology transactions.

E. Soviet Exports to Areas Other Than the United States

In its efforts to expand exports, the Soviet Union has attained relatively few successes in exporting manufactured products, especially machinery, to the West. Exports of Soviet equipment to the

less-developed countries are usually financed at least in part by credits extended on hard repayment terms. In most cases where Soviet exports have been subjected to the pressure of international competition, the outcome has been unfavorable, owing to the inferiority of Russian goods and attendant services (supply of parts, merchandising, packing, etc.). However, some kinds of industrial goods--e.g., metallurgical equipment, machine tools, and tractors--have found acceptance. It would be worthwhile to investigate the special conditions that may distinguish the production and marketing of these successful cases. Such an investigation should yield additional insight into Soviet export marketability, and into the lagging factor productivity and deceleration of economic growth in the Soviet Union more generally. It would be appropriate as part of this investigation to consider the impact that Soviet exports would have on American, Western European, and Japanese exports to other countries.

F. Opportunities for Technology Import from the Soviet Union

Differing views have been expressed as to how the United States might benefit from increased access to Soviet technology. At ve, reasons are advanced for anticipating fruitful results from such access.¹ It would be useful to bring this matter to a conclusion by pursuing several lines of inquiry. U.S. delegates to the U.S.-USSR Joint Commission on Scientific and Technical Cooperation, and the working groups established by the Commission, could be systematically interviewed to learn their views as to how the United States could facilitate the importation of useful technology from the Soviet Union, where the barriers to such transfer lie, and where the most lucrative opportunities are to be found. A similar inquiry directed toward U.S. businessmen who have visited the Soviet Union, or who have received visits from Soviet representatives, would be a useful extension. The aim would be to determine both the fields from which the U.S. would stand to benefit most by technology import, and the specific policy instruments--among those

¹See also DeHaven, *op. cit.*

alluded to above--that the U.S. government should negotiate with the Soviet Union.

G. Soviet and Eastern European Markets for High-technology Exports

It would be useful to adapt the multivariate regression method for estimating Soviet demand for Western computers--referred to above--to other high-technology fields. Admittedly, there are serious shortcomings to using cross-sectional and time-series data from Western European and U.S. experience to forecast potential Eastern European and Soviet demand for particular categories of high-technology products. The interindustry structure of the Soviet economy differs from that of Western Europe and the United States, both because of differences in resource endowments and, more especially, because the Soviet Union is a centrally planned economy in which priorities dictated by planners and doctrines can sharply alter investment and production schedules. Nevertheless, the Soviet Union has recently expressed strong interest in importing technology from the West as a means of offsetting its lagging productivity, rising capital-output ratios, and diminished growth rates. Consequently, Soviet central planners may be more inclined to borrow from and to emulate Western and U.S. technological developments than they have been in the past; indeed, they may be more inclined to do so than realistic appraisals of comparative cost and relative efficiency might warrant.

For these reasons, further development of the regression method for estimating demand for computers may be of interest. Subsequent work should be applied to other products, especially those still under U.S. and COCOM export controls, such as telecommunications equipment and numerically controlled machine tools. Such estimates, especially if combined with a closer analysis of Soviet capacity to pay, and if explicit allowance were made for structural differences between Soviet-type economies and those of the West, would help to provide the U.S. policy community with a better sense of the fields in which Soviet interest in technology import from the West is likely to be strongest and U.S. and Western export gains are likely to be greatest. A better appreciation of what we would be *gaining* and what we would be *giving*

through particular measures to relax controls would be helpful in inter-agency policymaking and in negotiations with the Soviet Union.

H. The Problem of Asymmetry: The Distribution of Gains in Transactions Between Single Buyers (Sellers) and Multiple Sellers (Buyers)

As noted earlier, Article 4 of the May 1972 accords allows agreements to be made for technological cooperation and joint activities "between agencies, organizations, and firms of both countries. . . ."¹ In the actual operation of Article 4, the United States may be at a disadvantage. Soviet agencies, under the coordination of the joint Commission on Scientific and Technical Cooperation, may be able to undertake transactions with the United States for buying or selling high technology from the standpoint of a more or less *unified* buyer or seller dealing with a *multiplicity* of U.S. firms. The situation may be one in which a single buyer is dealing with multiple sellers, notwithstanding the fact that Soviet agencies are far from perfectly competitive. Nevertheless, the advantage from such a market structure, in regard to the terms of trade and the distribution of gains between participants, may be asymmetrically in favor of the Soviet Union.

It should be of interest, then, to analyze from both a theoretical and an institutional standpoint, how the terms of trade are affected as the number of buyers (sellers) shrinks, and the number of sellers (buyers) grows. The result may be to uncover ideas for policy that would strengthen the relative bargaining position of U.S. firms.

2. U.S.-CHINA TECHNOLOGY EXCHANGE AND TRADE ISSUES

A. Effects of Western Technology on China's Military Capabilities

The investigation would be an exact counterpart of that described above concerning the effects of the acquisition of Western technology on Soviet military capabilities.² Like the proposed Soviet study, it

¹See above, Sec. I.

²See above, pp. 22-24.

would employ a Delphi technique and would make precise calculations of potential military consequences, perhaps also using precision-guided munitions as a case in point.

B. Impacts on the Soviet Union of Possible Increases in Chinese Military Capabilities Resulting from Acquisition of Western Technology

It is not entirely clear whether increases in Chinese military effectiveness owing to the acquisition of Western technology (see 2A, above) would be harmful or beneficial to the interests of the United States and its allies. One aspect of studying this point is the probable effect of incremental Chinese capabilities on the Soviet Union's defense budget and deployment decisions. A Rand study of the interactions among the defense budgets of China, the Soviet Union, and the United States suggests that the interaction between China and the Soviet Union is much more pronounced than that between either country and the United States.¹

It should be of interest to apply this earlier work to a finer-grained investigation of the effects of potential increases in Chinese military capabilities, resulting from the import of Western technology, on Soviet military resource allocations. Viewed in this light, some increases in Chinese capabilities--e.g., stronger air defenses--may be beneficial rather than harmful to the interests of the United States.

C. China's Capacity to Pay

This study would be an exact counterpart of that concerning the Soviet Union, discussed above. Although Chinese gold production and sales are not likely to make up a significant part of the study as they do for the Soviet Union, other aspects of the capacity-to-pay study (i.e., potential increases in China's exports, and its access to foreign credits) would apply. Again, the pervasive effect of this issue on trade and technology exports to China warrants some closer attention.

¹ J. H. Despres and P. J. Dhrymes, *Defense Budget Interactions: Preliminary Econometric Analysis of U.S., Soviet, and Chinese Competition* (U), R-1390-PR, The Rand Corporation, November 1973 (Secret).

3. GENERAL ISSUES OF INTERNATIONAL TECHNOLOGY EXCHANGE AND COOPERATION

International technology exchange with Western Europe and Japan involves problems and opportunities that in some respects transcend those of transactions with communist countries. Two such issues are the following.

A. International Cooperation To Reduce Government R&D Costs

If U.S. government R&D were sponsored jointly with other countries, particularly some of our NATO allies and Japan, the United States might be able, by sharing the R&D burden, to increase the yield from its R&D resources. Although the idea is not new--and our limited experience with it not very encouraging--one particular aspect of it is novel and timely in a period of tight defense budgets. The suggestion is that international cooperation in R&D be undertaken on a large scale for efficiency purposes, rather than on a small scale for political purposes. For example, R&D contracts might be opened to foreign bidders, who might in some cases be cheaper than U.S. contractors. Some degree of reciprocity (it would not have to be symmetrical) should be sought, so that U.S. contractors could bid on the R&D contracts of foreign governments as well.

Joint R&D in the area of coal and other energy technologies would be both important and timely. It is an area well suited to international cooperation, especially with the Japanese and the West Germans--with the former because of their critical dependence on fuel imports, and with the latter because of their experience in some aspects of developing synthetic crude oil from coal supplies.

B. The Relative Effects of Trade, Licensing, Multinational Corporations, and Foreign R&D on the International Dissemination of Technology

The aim of such a study would be to examine how particular firms obtain new technology, including the relative effects of product imports, licenses, association with multinational corporations, and the firms' own R&D. The area has been widely studied for several years, but insights into the process, especially into the relative effects of these various modes of technology transfer, remain shallow. Making

case studies of specific industries would be preferable to trying to contribute to the general discussion of the product cycle in the literature. Rand may, for example, have a comparative advantage in investigating the computer industry, one that would permit it to quantify and test some hypotheses in the product-cycle and technology-transfer literature. These hypotheses include the propositions (a) that imports of new products lead, in a predictable time, to the importing country's acquisition of the new technology by establishing an import-substituting industry, and (b) that a foreign country may acquire new technology by licensing from the United States, by imitating local affiliates of U.S. multinational corporations, and by encouraging government R&D.

Research in this area should permit more effective management of the several public policy instruments for contributing to, or impeding, international technology transfer.